REMARKS

Claims 1-11 and 13-36 are pending in the present application.

In the office action mailed August 25, 2005 (the "Office Action"), claims 1-11 and 13-36 were rejected by the Examiner under 35 U.S.C. 103(a) as being unpatentable over U.S. Patent No. 5,990,904 to Griffin (the "Griffin patent") in view of U.S. Patent No. 6,828,983 to Vijayakumar *et al.* (the "Vijayakumar patent").

Claims 1 and 18 have been amended to more clearly recite the subject matter being claimed. Claims 2 and 4-9 have been amended to be consistent with the amendments to claim 1. Claims 21 and 22 have been amended to be consistent with the amendments to claim 18. Claims 27 and 33 have been amended to correct grammatical errors resulting from previous amendments. It will be apparent from the amendments, and the comments below, that the amendments were made independent of the cited references. None of previously mentioned amendments narrow or further limit the scope of the invention as recited by the respective claim. Generally, the amendments make explicit what is implicit in the claim, add language that is inherent in the unamended claim, or merely redefine a claim term that is previously apparent from the description in the specification. Consequently, the amendments should not be construed as being "narrowing amendments," because these amendments were not made for a substantial reason related to patentability.

As previously mentioned, claims 1-11 and 13-36 have been rejected under 35 U.S.C. 103(a) as being unpantentable over the Griffin patent in view of the Vijayakumar patent.

The Griffin patent is directed to a graphics rendering system for merging pixel fragments. By merging the fragments, storage of an object tag or two depth values for each fragment is not required, thereby reducing the storage requirement to support fragment list processing. Additionally, fragments can be resolved faster because there are generally fewer fragments to resolve. Geometric primitives are rasterized to generate pixel data including pixel fragments for pixels partially covered by geometric primitives. The pixel fragments are stored in lists corresponding to a pixel locations in an image. When a new pixel fragment is generated, an attempt is made to merge this pixel fragment with one or more previously generated pixel fragments stored for the pixel location. If the color and depth of the newly generated fragment

are within predefined tolerances of the color and depth of a stored fragment in the list for the pixel location, then the newly generated and stored fragments are merged.

As described in the Griffin patent, a rasterizer receives geometric primitives and generates instances of pixel data that include color, depth, and coverage data. A pixel engine controls the transfer of the pixel data to pixel and fragment buffers. The pixel buffer comprises an array of elements corresponding to pixel locations, and each element stores color and depth data for fully covered pixels closest to the viewpoint. The fragment buffer stores color, depth, and coverage data for partially covered pixels. If pixel fragments are generated for a given pixel location, the pixel buffer element corresponding to that location stores a pointer to the head of a list of the pixel fragments in the fragment buffer.

The pixel engine performs a depth compare operation on newly generated pixel data. If a generated pixel is occluded by the pixel in the pixel buffer, it is discarded. However, if the generated pixel is a fully covered pixel and is not occluded by the pixel in the pixel buffer, it replaces the pixel in the pixel buffer. Candidates for pixel fragment merging include generated pixel fragments not occluded by a fully covered pixel at the pixel location of the generated pixel fragments. The color and depth of a candidate pixel fragment are checked to determine whether they are within predefined tolerances of the most recent fragment added to the list at the pixel location of the fragment. If so, the pixel engine merges the two fragments and stores the merged fragment at the head of the list. The alpha of a generated fragment can be considered as well in determining whether to merge two pixel fragments.

Merging an incoming fragment with a most recent fragment generated during the rasterizing process is advantageous because the most frequent fragment is a likely merge candidate. Additionally, merging with the most recent fragment saves hardware and clock cycles because it does not require fragment depth sorting or searching of the fragment list for each incoming fragment. Since adjacent geometric primitives are typically rasterized in close proximity to each other, the most recent fragment generated for a pixel location is likely to have common depth and color. As a result, attempting to merge with the most recent fragment can save a significant amount of fragment memory.

The Vijayakumar patent is directed to an anti-aliasing method where super-sampling is performed at the edges of primitives. By selectively super-sampling at the edges of

primitives, as opposed to super-sampling for an entire primitive, it reduces memory traffic, which in turn leads to reduced latency and increased rendering speed.

Claims 1, 10, 18, 24, and 33 are patentable over the Griffin patent in view of the Vijayakumar patent because the combined teachings fail to teach or suggest the combination of limitations recited by the respective claims.

For example, with respect to claim 1, the Griffin patent and the Vijayakumar patents fail to teach a method for calculating values or pixels of an image that includes separately shifting each of the transformed primitives of a plurality of transformed primitives in the second coordinate space by a respective first sub-pixel offset from a respective first pixel position to a respective first sub-pixel position. Each of the shifted primitives at the respective first sub-pixel position are rendered to generate values for a respective first set of pixels for the each shifted primitive. Each of the plurality of transformed primitives in the second coordinate space are separately shifted by a respective second sub-pixel offset from the respective first pixel position to a respective second sub-pixel position and separately rendered to generate values for a respective second set of pixels for each shifted primitive.

As previously discussed, the Griffin patent is directed to a graphics rendering system that merges pixel fragments from different geometric primitives where a newly generated fragment is within predefined tolerances of color and depth of a stored fragment in a list for the same pixel location. As described in the Griffin patent, geometric primitives, described by "triangle data" are converted into pixel data by a process of rasterization. *See* col. 29, line 61-col. 30, line 40. Pixel fragment data, which is generated by a pixel engine 466 and results when a pixel is not entirely covered by a primitive, are stored for each pixel fragment in the fragment buffer 470. An anti-aliasing engine 468 resolves the data in the fragment buffer 470. In generating the pixel data, including the pixel fragment data, the geometric primitives are rasterized once. In contrast, as recited in claim 1, each of the primitives of a plurality are shifted and then rendered at a plurality of sub-pixel sample locations. Nowhere in the Griffin patent is there a description of shifting a primitive to various sub-pixel sample locations or rasterizing a primitive more than once at the different sub-pixel sample locations.

The Examiner argues that the description for computation of a coverage mask found in the Griffin patent teaches shifting a geometric primitive. *See* the Office Action at page

3. However, the material cited by the Examiner, namely col. 34, line 64-col. 35, line 16, merely describes a technique of using a coverage mask to represent partial coverage of a pixel by a primitive and the slope of a primitive edge for the pixel fragment. There is no description of shifting the primitive relative to the pixel, but merely a description of a two step process for computing a coverage mask. The first step is to determine which of the sub-pixel bits are "turned on" to represent coverage by a primitive. The second step determining the order in which the sample bits are to be turned on to represent the correct range of slope values. Neither step includes shifting a primitive by a sub-pixel offset.

Similarly, the Vijayakumar patent fails to describe either shifting or rasterizing at different sub-sample locations. As previously discussed, the Vijayakumar is directed to performing super-sampling for pixels that are intersected by an edge of a geometric primitive, as shown in Figure 15. The super-sampling that is discussed can be performed using the sampling patterns shown in Figures 3 and 4. The Examiner argues that the Vijayakumar describes rendering a primitive at different sub-pixels sampling positions. *See* the Office Action at page 4. However, the material cited by the Examiner, namely col. 9, lines 12-20, does not describe rendering a primitive at a sub-pixel location, but describes super-sampling for a pixel intersected by an edge of a primitive. By this step, rendering has already been performed to define the pixels. *See* col. 5, lines 46-51. Anti-aliasing is performed by super-sampling the pixels that are intersected by an edge of a primitive. The primitive is not "rendered" using super-sampling, despite the Examiner's assertions, since the primitive has already been rendered by this time. Thus, the use of super-sampling occurs after rendering, and not as part of it.

Claims 10, 18, 24, and 33 are also patentable over the Griffin patent in view of the Vijayakumar patent. Claim 10 recites a method for calculating values for pixels of an image including separately issuing each geometric primitive of the scene a plurality of times. For each issuance of one of the geometric primitives, the geometric primitive is shifted by a sub-pixel offset from a first pixel position to a respective sub-pixel position and the shifted geometric primitive is rendered to generate values for a respective set of pixels for the shifted geometric primitive at the respective sub-pixel position. Claim 18 recites a method for calculating values for pixels of an image including shifting transformed primitives as an individual primitive by a sub-pixel offset from a first pixel position to a respective sub-pixel position corresponding to a

respective one of the sampling locations of the sampling pattern and individually rendering the shifted transformed primitive to generate values for a respective set of pixels for the transformed primitive shifted to the respective sub-pixel position. Claim 24 recites a graphics system including a rendering stage configured to separately issue each of the geometric primitives a plurality of times, and for each issuance of one of the geometric primitives, the rendering stage shifts the geometric primitive a respective sub-pixel offset from a first pixel position to a respective sub-pixel position and calculates values for respective sets of pixels representing the shifted geometric primitive at the respective sub-pixel position. Claim 33 recites a graphics system including a multi-stage processing pipeline configured to separately reissue each geometric primitive for each sampling location of a sampling pattern. Each time the geometric primitive is issued, a transformed primitive is shifted by a sub-pixel offset from a first pixel position to a respective sub-pixel position corresponding to a respective one of the sampling locations of the sampling pattern and the shifted primitive is rendered at the respective sub-pixel position to generate values for a respective set of pixels for the geometric primitive shifted to the respective sub-pixel location.

The combined teachings of the Griffin patent and the Vijayakumar patent fail to teach or suggest at least these limitations recited in claims 10, 18, 24, and 33. As previously discussed with respect to claim 1, neither the Griffin or Vijayakumar patents teach shifting a geometric primitive or separately rendering each primitive at each of the sub-pixel sample locations. The shifting that has been argued by the Examiner as being described in the Griffin patent only describes the computation of a pixel coverage mask that is used to represent coverage of a pixel by a primitive. Sub-pixel bits can be switched "on" or "off" to represent the area that is covered by an intersecting edge of a primitive. The order in which the bits are switched on represents a range of slope values for the slope of the intersecting edge. With respect to rendering, the Vijayakumar patent describes super-sampling a pixel intersected by an edge of a geometric primitive. However, as previously discussed, by the time the determination is made regarding which of the pixels are intersected (i.e., partially covered) and should be super-sampled, the primitives have already been rendered.

For the foregoing reasons, claims 1, 10, 18, 24, and 33 are patentable over the Griffin patent in view of the Vijayakumar patent. Similarly, claims 2-9, which depend from

claim 1, claims 11 and 13-17, which depend from claim 10, claims 19-23, which depend from claim 18, claims 25-32, which depend from claim 24, and claims 34-36, which depend from claim 33, are similarly patentable based on their dependency from a respective allowable base claim. That is, each of the dependent claims further narrows the scope of the claim from which it depends, and consequently, if a claim is dependent from an allowable base claim, the dependent claim is also allowable. Therefore, the rejection of claims 1-11 and 13-36 under 35 U.S.C. 103(a) should be withdrawn.

All of the claims pending in the present application are in condition for allowance. Favorable consideration and a timely Notice of Allowance are earnestly solicited.

Respectfully submitted,

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